International Journal of Pharmacy and Industrial Research (IJPIR)

IJPIR |Vol.14 | Issue 4 | Oct - Dec -2024

www.ijpir.com

DOI : https://doi.org/10.61096/ijpir.v13.iss4.2024.465-470

ISSN: 2231-3656
Print: 2231-3648

Review

A Review on Floating Drug Delivery Systema

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Published on: 17 Nov 2024

Published by:
DrSriram Publications

Abstract

This review explores the advancements in Floating Drug Delivery Systems (FDDS), emphasizing their classification, mechanisms, and methodologies for sustained drug release. FDDS enhance the bioavailability of drugs with short half-lives by prolonging their retention in the gastrointestinal tract. Key technologies include effervescent and non-effervescent systems, raft-forming systems, and floating microspheres, each offering distinct advantages in gastric retention and drug release kinetics. The paper also discusses the preparation methods, such as direct compression, dry granulation, and wet granulation, and evaluates critical parameters like floating lag time, bulk density, and dissolution profiles. FDDS present a promising approach for targeted drug delivery in the upper gastrointestinal tract, addressing challenges in drug absorption and therapeutic efficacy.

Keywords: Floating Drug Delivery System (FDDS), Gastric retention, Sustained release, Effervescent system, Non-effervescent system, Floating microspheres, Raft-forming systems, Bioavailability enhancement, Gastrointestinal retention time, Controlled drug release.

INTRODUCTION

The solid oral dosage forms such as capsule, tablets gives specific drug concentration in systemic blood circulation without getting any control over drug delivery system and also cause major fluctuations in plasma drug concentrations. The most convenient and preferred means of any drug delivery to the systematic circulation is the oral Administration To achieve improved therapeutic advantages the oral controlled release drug delivery system have recently been of increasing interest in pharmaceutical field. such as ease of administration of doses, patient compliance towards the product and flexibility in formulation of drug. Those drugs are eliminated quickly from the systemic circulation who are easily absorbed from gastrointestinaltract [GIT] and have short half- life. the development of sustained -controlled release oral formulations is to avoid this limitation and it is an attempt to release the drug slowly into the gastrointestinal tract and maintain the therapeutic drug concentration in the blood circulation for a long period of time.

Classification of floating drug delivery systems

(A) Effervescent system floating drug delivery system

These are particular drug delivery system made up of matrix type and a swellable polymer such as methylcellulose and chitosan along with effervescent compounds viz. sodium bicarbonate, tartaric acid, citric acid. These are formulated in such a specific way as once it comes in contact with gastric juice; co_2 gets liberated with entrapment in swollen hydrocolloid to provide buoyancy for dosage form. The basis of the delivery system is on swellable asymmetric triple layer tablet approach design.

(I) Gas generating systems

Low-density FDDS is based on the release of co_2 upon contact with gastric fluids after oral administration. The materials are formulated in such a way that after entering in the stomach, co_2 is librated due to reaction with acidic gastric content and which get entrapped in the gel-based hydrocolloid . It produces an upward motion of the dosage form and maintains its buoyancy. Ultimately it causesa decrease in specific gravity of dosage form and hence resulting into a float on the chime. The co_2 generating components are mixed within the tablet matrix in a single layer or multi-layered form to produce gas generating mechanism in hydrocolloid layer,and the drug in the other layer results into a sustained release effect .

(II) Volatile liquid containing systems (Osmotically controlled drug delivery system)

This is an osmotically controlled floating system in which a device comprised of a hollow deformable unit in convertible collapsed form. Housing would be attached to its deformable unit and internally divided into a first and second chamber separated by an impermeable, pressure sensitive movable unit. The first chamber usually contains an active drug, while the second a volatile liquid, such as cyclopentane or ether get vaporized at a physiological temperature to produce a gas, enabling the drug reservoir to float. The unit gets expelled from the stomach, with the help of bioerodible plug that allowed the vapour to escape

(B) Non-effervescent FDDS

Non-Effervescent Floating Drug Delivery Systemscomprises a gel-forming (or) swellable cellulose type of hydrocolloids made up of polysaccharide along with matrix forming polymers like polycarbonate, polymethacrylate,and polystyrene. The routine formulation method involves the mixing of the drug with gel forming hydrocolloids that swell in contact with gastric fluid upon oral administration and maintains the integrity of shape and a bulk density barrier, the air trapped by swollen polymer confer buoyancy to the dosage forms.

(I) Colloidal gel barrier systems (Hydrodynamic balanced systems)

This system prolongs gastric retention time and maximizes the amount of drug that reaches its absorption site in the solution form. It essentially contains drug with gel-forming hydrocolloids to remain buoyant on the stomach content. Such a system incorporates one or more gel-forming cellulose type hydrocolloid e. g. hydroxypropylmethylcellulose (HPMC), polysaccharides and matrix forming polymers such as polycarbophil, polystyrene,and polyacrylate. Upon contact with gastro-Intestinal (GI) fluid, the hydrocolloid in the system hydrates to generate a colloid gel barrier to its surrounding..

(II) Microporous compartment systems

This technology incorporates the encapsulation technique of a drug reservoir inside a microporous compartment along with pores at top and bottom walls. The peripheral wall of the drug reservoir compartment is completely sealed to prevent any direct contact of the gastric surface with the undissolved drug. In the stomach, the floatation chamber composed of entrapped air causes the delivery system to float over the gastric content. Gastric fluid enters through the aperture, to the extent that it prevents theirsexist from the drug and carrier the dissolved drug for continuous transport across the intestine for absorption.

(III) Floating Microspheres/Micro balloons

Hallow microspheres also are known as micro balloons are considered as a most efficient buoyant system. It is composed of central hallow space inside the microsphere. Hallow microsphere is loaded with a drug in their outer polymer shelf are fabricated by a novel solvent Diffusion method for emulsion .

(IV) Alginate beads/Floating beads

Multi-unit floating dosage forms have been developed from calcium alginate spherical beads of about 2.5 mm in diameter and can be fabricated by adding sodium alginate solution into aqueous solution of calcium chloride, resulting in the precipitation of calcium alginate, the beads are further separated, snap-frozen in liquid nitrogen and freeze-dried at 400 °C for 24 h, leads to generation of a porous system. This fabricated system would maintain a floating force for over 12 h and these floating beads provide a longer residence time of more than 5.5 h**.**

(C) Raft-forming systems

Raft-forming systems are in much attention for the delivery of antacid and drug delivery for gastro infection and disorders. On contact with gastric fluid, a gel-forming solution swells and forms a viscous cohesive gel entrapped with co_2 bubbles which generate raft layer on top of gastric fluid, thus facilitates releases drug slowly in the stomach.

Mechanism of floating system

Various attempts have been made up to retain the dosage form in the stomach as a way of increasing the retention time. These attempts include introduction floating dosage forms mucoadhesive systems, high – density system, modified shape system, gastric emptying delaying drugs. Among these the floating dosage forms are the most commonly used. Floating drug delivery systems FDDS. Have bulk density less than gastric fluids and so remain buoyant in the stomach without affecting the gastric emptying rate for a prolong period of time. While the system is floating on the gastric contents the drug isreleased slowly at the desired rate from the system. After release of drug the residual system is eliminated from the stomach. This results in an increased GRT and a better control of the fluctuation in plasma drug concentration.

Methods of preparation

Methodology for single layer floating tablets: Basically single layer floating tablets are prepared by compression methods. For this normally three basic compression methods are used. They are as follows:-

- Direct compression
- Dry granulation
- Wet granulation.

Direct compression method

Direct compression is the process of compressing tablets directly from powdered materials without modifying physical nature of materials into the tablets. This method is used for crystalline chemicals having good compressible characteristic and flow properties such as: Potassium salt (chloride, chlorate, bromide), Ammonium chloride, Sodium chloride, Methenamine etc. Compressed tablets are prepared by single compression using tablet machines. After a quantity of powdered or granulated tabletting material flow into a die, the upper and lower punches of the tablet machine compress the material under a high pressure (~tons/in2)

Dry granulation method

It is defined as the formation of granules by slugging, if the tablet ingredients are sensitive to moisture and/or unable to withstand elevated temperature during drying.

Wet granulation method

In wet granulation the active ingredient, diluents and disintegrants are mixed or blended well in a rapid mixer granulator (RMG). The RMG is a multi-purpose chopper which consists of an impeller and a chopper and is used for high speed dispersion of dry powders and aqueous or solvent granulations. Moist materials from wet milling steps are placed on large trays and placed in drying chambers with a circulating air current and thermo stable heat controller. Commonly used dryers are tray dryer, fluidized bed dryer. After drying, the granules are reduced in particle size by passing through smaller mesh screen. After this, the lubricant or glidant is added as fine powder to promote flow of granules. These granules are then compressed to get a tablet. Dry granulation when compared with wet granulation has a shorter, more costeffective manufacturing process. Because it does not entail heat or moisture, dry granulation is especially suitable for active ingredients that are sensitive to solvents, or labile to moisture and elevated temperatures

METHOD OF EVALUATION

Bulk density: It is a ratio of mass of powder to bulk volume. The bulk density depends on particle size distribution, shape and cohesiveness of particles. Accurately weighed quantity of powder was carefully poured in to graduated measuring cylinder through large funnel and volume was measured, which is called initial bulk volume.

It is expressed in gm/ml and is given by the formula:(15)

Bulk density=M/Vo

Where, M = mass of the powder

Vo = bulk volume of the powder.

Tapped density: 10 gm of powder was introduced into a clean, dry 100 ml measuring cylinder. The cylinder was then tapped 100 times from a constant height and the tapped volume was read. It is expressed in gm/ml and is given by: (16)

Tapped density=M/Vt Where,

M = mass of the powder

Vt = final tapping volume of the powder.

Angle of repose (θ): is defined as the maximum angle possible between the surface of the pile of the powder and the horizontal plane. Fixed funnel method was used. A funnel was fixed with its tip at a given height 'h, above a flat horizontal surface to which a graph paper was placed. Powder was carefully poured through a funnel till the apex of the conical pile just touches the tip of the funnel. The angle of repose was then calculated using following equation:(17)
Angle of repose Ø = tan1(h/r)

Hausner's ratio: Hausner's ratio is used to predict the flowability of the powders. This method is similar to compressibility index.
Hausner's ratio can be represented by equation:
Hausner's ratio = Tapped density / bulk density

Weight Variation test (U.S.P.): Take 20 tablet and weighed individually. Calculate average weight and compare the individual tablet weight to the average. The tablet pass the U.S.P. test if no more that 2 tablets are outside the percentage limit and if no tablet differs by more than 2 times the percentage limit(18)

Hardness: Tablet hardness and strength are the essential to see that the tablet can with the shock and stress during manufacturing packing and transportation, and while handled by the patient To test the hardness of the tablet Monsanto tester, Strong-cobb tester, the Pfizer tester, the Erweka tester, the Schleuniger tester are used.(19)

Dimensionl Analysis: The thickness and diameter of tablets was determined using vernier caliper. Twenty tablets from each batch were used and average values were calculated. Size and Shape It can be dimensionally described & controlled. The thickness of a tablet is only variables.
Tablet thickness can be measured by micrometer or by other device. Tablet thickness should be controlled within a ± 5% variation of standard value (20)

Floating lag time and total floating time: Floating lag time (FLT) and total floating time (TFT) of floating tablets were measured visually in dissolution apparatus type II containing100 mL 0.1 N HCl with a paddle rotated at50 rpm (pH 1.2) at 37 ± 0.5 °C.21

Dissolution Study: In vitro drug release of the formulation was carried out using USP dissolution apparatus type II paddle type under sink condition with rotating speed of 50 rpm and at temperature of37 ± 0.5 °C. The dissolution medium used was 900ml 0.1NHCl. The samples were withdrawn at predetermined time intervals for period of 6hours and replaced with the fresh medium, suitably diluted and were analyzed using UV/Visible spectrophotometer.22

Disintegration Test (U.S.P.): The U.S.P. device to test disintegration uses 6 glass tubes that are 3" long; open at the top and 10 mesh screens at the bottom end. To test for disintegration time, one tablet is placed in each tube and the basket rack is positioned in a 1-L beaker of water, simulated gastric fluid or simulated intestinal fluid at 37 ± 2 0 C such that the tablet remain 2.5 cm below the surface of liquid on their upward movement and not closer than 2.5 cm from thebottom of the beaker in their downward movement Move the basket containing the tablets up and down through a distance of 5-6 cm at a frequency of 28 to 32 cycles per minute. Floating of the tablets can be prevented by placing perforated plastic discs on each tablet. According to the test the tablet must disintegrate and all particles must pass through the 10 mesh screen in the time specified. If any residue remains, it must have a soft mass.

Disintegration time: Uncoated tablet: 5-30 minutes coated tablet: 1-2 hours.23 7. Conclusion: Floating tablets have emerged as the power full means of improving the bioavailability and providing sustained release and avoiding the adverse effects of many drugs. Floating tablets have proved to be potential approach for gastric retention. These systems have special advantage for the drug that are primarily absorbed from the upper part of GIT. So with an improved knowledge of formulation development aspect, physiochemical and pharmacological prospects of drug there is lot of future scope for designing of optimum floating drug delivery system.

CONCLISION

Floating Drug Delivery Systems (FDDS) represent a significant advancement in oral drug delivery technology, addressing critical challenges in improving bioavailability and therapeutic efficacy for drugs with narrow absorption windows. By leveraging various approaches, such as effervescent systems, non-effervescent systems, and raft-forming mechanisms, FDDS prolong gastric retention time, enhance drug stability, and facilitate

controlled release. The ability of FDDS to optimize drug absorption in the upper gastrointestinal tract positions them as a valuable solution for managing diseases that require precise and sustained drug delivery.

Despite the promising potential, the successful application of FDDS requires meticulous attention to formulation parameters such as floating lag time, bulk density, and dissolution profiles. Advances in preparation techniques, including direct compression and granulation methods, further expand the applicability of FDDS across diverse therapeutic areas.

Future research should focus on overcoming limitations such as variability in gastric motility and the influence of food on system performance. Additionally, integrating novel excipients and exploring hybrid systems could pave the way for more robust and versatile FDDS formulations. By addressing these challenges, FDDS can significantly enhance patient compliance and treatment outcomes, marking a pivotal step in modern drug delivery systems.

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